## *An Account and Deſcription of three* PENDULUMS *invented and conſtructed by* JOHN CROSTHWAITE, *Watch and Clock Maker, Dublin.*

FIG. I. repreſents a pendulum, with a ſimple mode of compenſation, which has now been going eighteen years, much more accurately than could be expected in ſo very unfavourable a ſituation: the firſt ten years againſt a lath and plaiſter partition, within three feet of the external wall, and the ſame diſtance from a hall-door, the frequent ſhutting of which muſt have very much diſturbed its vibrations; the laſt eight years, againſt an external wall only three feet from the ſtreet; which, though a much better ſituation than the former, yet even here it was liable to have the iſochroniſm diſturbed by the carriages almoſt conſtantly paſſing.

Read Nov. 1, 1787.

A and B are two rods of ſteel forged out of the ſame bar, at the ſame time, of the ſame temper, and in every reſpect ſimilar. On the top of B is formed a gibbet C; this rod is firmly ſupported by a ſteel bracket D, fixed on a large piece of marble E, firmly ſet into the wall F, and having liberty to move freely upwards between

between croſs ſtaples of braſs 1, 2, 3, 4, which touch only in a point in front and rere (the ſtaples having been carefully formed for that purpoſe); to the other rod is firmly fixed, by its centre, the lens G, of twenty-four pounds weight, although it ſhould in ſtrictneſs be a little below it. This pendulum is ſuſpended by a ſhort ſteel ſpring on the gibbet at C, all which is intirely independent of the clock. To the back of the clock plate I are firmly ſcrewed two cheeks nearly cycloidal at K, exactly in a line with the centre of the verge L. The maintaining power is applied by a cylindrical ſteel ſtud in the uſual way of regulators, at M. Now, it is very evident that any expanſion or contraction that takes place in either of theſe exactly ſimilar rods, is inſtantly counteracted by the other; whereas in all *compenſation* pendulums compoſed of different materials, however juſt calculation may ſeem to be, that can never be the caſe, as not only different metals, but alſo different bars of the ſame metal that are not manufactured at the ſame time, and exactly in the ſame manner, are found by a good pyrometer to differ materially in their degrees of expanſion and contraction, a very ſmall change affecting one and not the other; this, however, is by their framers always tried by the pyrometer, and any defect experimentally remedied by hammering or filing; but it, notwithſtanding, requires a length of time, much expence, and an inſtrument not always accurate. It is very evident, that whenever diſſimilar rods are introduced to counteract each other, diſorders will take place in the moſt ſuſceptible, ſometime before the remedy is applied by the moſt tardy, and that this remedy or compenſation continues ſometime after the occaſion for it ceaſes; and therefore in this country, where the temperature of the atmoſphere is ſubject to ſuch various and ſudden changes; when compenſations

ſations are uſed, they ſhould be executed with the ſame materials as that of the pendulum rod, and have exactly the ſame expoſure to the air.

A DESCRIPTION of a pendulum, with a diamond ſuſpenſion.—The lens is ſeven inches diameter, made of lead melted into a braſs ſhell, very accurately weighed in all poſitions, turned truly in a very ſteady lathe, firſt flatwiſe, and then on an arbor through its centre, and adjuſted ſo that in all ſituations the centre of gravity of the lens exactly coincides with the axis of the pendulum rod; a piece of braſs, half an inch thick and three and an half long by two broad, is let into the lead ſo as to be even with its ſurface; four holes being tapped in it to receive the ſcrews c c c c, Fig. II. with their heads counterſunk in the braſs ſhell: this piece of braſs is hollowed lengthwiſe on the inſide, ſo as to embrace the pendulum rod, the whole length of itſelf, but moſt ſtraightly at its centre. The lens never to be altered after the clock is brought to time. The rod made of red deal, firſt baked, then boiled in linſeed oil for a conſiderable time, and then well varniſhed. On the top is formed an irregular octagon and an opening cut through, of the ſhape of the letter U; there is drilled in the lathe, exactly through its centre lengthwiſe, a hole to receive the piece of very hard caſt ſteel e, which after being fitted ſquare into a braſs collar f, paſſes through the hole in the upper part of the pendulum rod at 5, and is there firmly ſecured by a ſcrew, the head of which is counterſunk in the top of the rod; at 6 the ſteel piece is wrought to a fine conical point, on which the whole pendulum is ſuſpended on the well-levelled face of a large diamond; this diamond is ſet and

ſoldered with ſilver into a tempered piece of ſteel g, having three levelling ſcrews h h h, carefully tapped through it. The points of theſe tempered ſcrews are rounded and lie in beds formed for them in I, a piece of ſteel $\frac{7}{10}$ of an inch broad on the upper ſide; the lower part being rounded, this is very firmly leaded into a piece of ſtatuary marble K, about two hundred weight, firmly inſerted in the wall, ſo as juſt to admit the ſteel piece I to paſs through the back of the clock caſe: The pendulum being entirely detached from the clock and ſuſpended on the diamond, and the whole upon the wall. Before the clock was applied, it continued vibrating twenty-ſeven hours in this detached ſtate as a ſimple pendulum. I have applied the maintaining power from the movement by a well-tempered and poliſhed ſteel cylinder $\frac{1}{14}$ of an inch diameter, firmly ſcrewed to the crutch through the opening in the braſs collar L; in this opening I have fixed two pieces of ſapphire, of which this is the ſection ⊍, the cylindrical ſides which the hard ſteel cylinder above-mentioned acts againſt being well poliſhed, the contact is lineal. To the back of each of thoſe pieces of ſapphire I have fitted two ſcrews o, o, tapped through the braſs collar L, which firmly embraces the pendulum rod. By theſe ſcrews the pieces of ſapphire are accurately adjuſted to the ſteel cylinder, ſo that the power is applied, without the ſmalleſt ſhake or loſs of force, exactly in the line of the centres of oſcillation, gravity and ſuſpenſion.

An account of a clock where the maintaining power is applied immediately from the eſcapement wheel to the axis of the pendulum rod, without verge, crutch, or any other agent.—I cut a notch

notch in the pendulum rod deeper than its axis, (ſee the profile, Fig. III.) and in that opening at k, and in that part on a plate of braſs fixed firmly by ſcrews, two pallets r and s, repreſented larger at Z below, and by the eſcapement wheel P, with pins 1, 2, 3, 4, 5, 6, &c. made of very hard drawn braſs wire inſtead of teeth, I applied the maintaining power exactly in the line of the centres of magnitude, oſcillation, ſuſpenſion, motion and gravity. This appears to me the moſt ſimple and perfect method of applying the maintaining power to pendulums that has hitherto been thought of, and if perfectly executed with ruby or ſapphire pallets, and hard ſteel pins well finiſhed in the wheel, the point of ſuſpenſion made perfectly immoveable, and the maintaining power perfectly uniform, then perhaps the faireſt trial may be given to different pendulums.

On ſhewing my clock made in this way to an ingenious gentleman from London, he told me he ſaw one executed on the ſame principles in England. I went to ſee it, and found it ſomewhat like mine, but the maker had not thoſe matters in view that I had, as he did not communicate the power at the centre of the rod, but on its external part, by which means much of the power was loſt, and the remainder gave the pendulum an undulatory motion which added conſiderably to the friction, and totally deſtroyed the iſochroniſm *.

* Since theſe clocks were made, I conſtructed another very ſimple one, in which I made the pendulum to vibrate at right angles with the plane of the eſcapement wheel: this method promiſes ſome material advantages, particularly in large clocks.